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Engineering

HYDROLOGY NOTE NO. 1 (REV. 1)

ESTIMATES OF PEAK RATES OF RUNOFF USING MEASURED STREAMFLOW DATA

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TABLE OF CONTENTS

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I. Background

For project planning and evaluation purposes, it is important that the Soil Conservation Service have a consistent and accurate technique for estimating flood flow frequencies. For this reason, SCS has had a long-standing interest and involvement ~~in~~ Federal interagency efforts to systematize various aspects of flow frequency determination. In December 1967, Bulletin No. 15, "A Uniform Technique for Determining Flood Flow Frequencies," was issued by the Hydrology Committee of the Water Resources Council. Bulletin 17, "Guidelines for Determining Flood Flow Frequency," an extension and update of Bulletin 15, was completed in March 1976. Bulletin 17B (July 1981) revises and replaces Bulletin 17A (June 1977) which did the same for Bulletin 17. No further revisions to the document are anticipated.

II. Policy

1. Field hydrologists at the State and TSC levels are encouraged to work with counterparts from Federal and State agencies to resolve differences in flood flow frequency estimates due to different interpretations or applications of procedures.

2. Principles and guidelines described in Bulletin 17B are to be used for determining flood flow frequency at all locations where at least 10 years of systematic record of peak flood flows are available.

3. Where Bulletin 17B refers to more than one procedure, an acceptable procedure will be recommended.

4. Procedures will be developed for problems not adequately covered in Bulletin 17B.

5. The Hydrology Unit (NES-HU) will assist with flood frequency problems that are unique or particularly difficult on request to the National Hydrologist.

III. Recommendations

A. Skew

The solution of the proper skew value to use is a judgment decision. For most situations, the skew weighing procedure in Bulletin 17B is adequate. A comparison between frequency curves using station skew and the weighted skew should be made when large differences between station and generalized skew occur. The station skew frequency curve may be more reasonable to use.

Skew studies over small regions should provide more accurate generalized and weighted skew values than the Plate I map in the bulletin. The Plate I study did not analyze the stations used following the Bulletin 17B procedure. Plate I also includes only a standard of error value for the entire map. The error can vary significantly from one area of the country to another and therefore is not really representative of any particular area. Plate I should only be used when other data are not acceptable or not available.

B. Outliers

For most situations, the outlier tests and adjustments in Bulletin 17B should be adequate. Comparisons should always be made between frequency curves with outlier adjustments and those without to be aware of the impact of the outlying values on the frequency curve. In situations where high outliers are indicated but no historic recurrence period is available, an estimate of the recurrence period should be made and the outlier so adjusted.

C. Mixed Distributions

Bulletin 17B does not include a specific procedure for handling mixed populations. Reference to procedures used by the Corps of Engineers (11) "Frequency of New England Floods" is given in Bulletin 17B. An alternative technique for handling this problem is contained in a "Discussion of Mixed Distributions," appendix 1.

Discussion of Mixed Distributions

A mixed population is a group of data which appear to be homogeneous but for some reason are not really homogeneous. In flow frequency analysis, a sample composed of annual peaks at a given site along a stream can be from a single population or a mixed population. The mixture would occur if the series of peaks are caused by various types of runoff events. Different types of runoff producing events include generalized rainfall, local thunderstorms, hurricanes, snowmelt or any combination. Examination of precipitation and other hydrologic records may help separate a series into two populations.

Standard frequency analysis techniques involving mixed populations may or may not be valid. If the mixture is due to a single or small group of values, these values could appear as outliers. An outlier is a data value or group of values that significantly depart from the remaining sample values. Using some outlier detection criteria, these values can be identified and deleted from the sample. The sample can then be analyzed without the outlying values. If enough values depart from the trend of the data, a second trend may be formed. The two trends can easily be seen when the data are plotted by order of magnitude on probability paper.

Data with two trends will cause problems in analysis. The skewness will increase in magnitude much greater than the skewness of either trend if single population analysis is attempted. A larger degree of curvature associated with the increased skewness magnitude will cause a departure of the computed frequency curve from the sample data in the region of the point common to both trends. The computed curve will not be representative of either trend near this point unless truncated series corrections can be made.

An alternative approach of analysis involves separating the two data trends by cause, analyzing each by itself, and then recombining. The steps of the procedure follow:

1. Determining cause for each trend. The list of runoff producing events previously listed should be used. If no specific cause can be found for each trend, the method cannot be used.

2. Separate the annual series into a series for each cause found in step one. Some data values may be common to more than one series. Snowmelt and generalized rainfall, for example, sometimes form a combination that would belong to two series.

3. Collect data for each causative series to make them an annual series. This step may be difficult or impossible to accomplish in some cases. Some series will not have values for each year. A hurricane series in an area where hurricanes occur about every 10 years is a good example. If insufficient data for any causative series are a problem, the method will not work.

4. Analyze each annual series separately using standard frequency analysis techniques.

5. Combine the computed frequency curves by the addition rule of probability:

$$P\{A \cup B\} = P\{A\} + P\{B\} - P\{A \cap B\}$$

where:

$P\{A \cup B\}$ is the probability of an event of given magnitude from either series occurring, $P\{A\}$ and $P\{B\}$ are the probabilities of an event of given magnitude occurring from each series, and $P\{A \cap B\}$ is the probability of an event of a given magnitude occurring in each series in the same year (i.e., $P\{A\} \times P\{B\}$).

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References:

1. Crippen, J.R., "Composite Log Type III Frequency Magnitude Curve of Annual Floods," Water Resources Division Bulletin, April - June 1968, pp 32-35.

2. Hoel, P.G., "5 the Additional Rule, Introduction to Mathematical Statistics, John Wiley and Sons, Inc., New York 1971, pp 10-13.